APPENDIX E

Upper East Coast Water Source Options

INTRODUCTION

Water Source Options

Several water source options were considered in this water supply plan. This appendix contains additional information for several of these options, including conservation, the Floridan Aquifer and surface water.

Water Conservation

The housing stock analysis by utility service area, used to estimate potential water savings associated with retrofit conservation measures is included in this section. The dates presented represent years when changes were made to the plumbing code as described in the UEC Planning Document.

Floridan Aquifer

This section provides a detailed summary of the comprehensive Floridan Aquifer monitoring well network that was established to monitor the effects of sustained withdrawals on the aquifer pursuant to the recommendations in the 1998 Plan. The purpose of the Floridan Aquifer monitoring network is to provide water level, water quality and water use data in high use areas (citrus groves) to determine statistical trends and relationships between the three data sets. Understanding these relationships will aid in the allocation of water from the Floridan Aquifer, and planning for long-term water supply in the region.

Surface Water

A link to the conceptual drawing of the Ten Mile Creek Critical Restoration Project is provided in this section. The recommended CERP Indian River Lagoon – South Project map is also presented.

WATER CONSERVATION

Housing Stock Analysis

The housing stock analysis includes counts and percentages of units constructed before rain sensor rules and plumbing codes went into effect (pre-1984, 1984–1994, 1994–2000). **Tables E-1** through **E-4** shows the counts and percentages of housing in each age group in each utility service area for Martin and St. Lucie counties.

Plumbing Codes

To determine housing with greater potential for indoor retrofits, unit age of the residential units was compared to years when plumbing code changed (pre-1984, 1984–1994, 1994–2000). **Tables E-1** and **E-2** show the counts and percentages of housing in each age group in each utility service area for Martin and St. Lucie counties.

Table E-1. Analysis of Martin County Housing Stock in Relation to Indoor Plumbing Code Changes.

Utility Service Area	Housing Stock			
	Pre 1984	1985-1994	Post 1994	Total
Indiantown Water Co.	765 87%	61 7%	51 6%	877
Martin County – Martin Downs	413 22%	1,308 69%	188 10%	1,909
Martin County – North	3,027 76%	778 20%	181 5%	3,986
Martin County – Port Salerno	2,814 64%	1,338 30%	279 6%	4,431
Martin County – Tropical Farms	316 72%	99 22%	26 6%	441
Miles Grant/Utility Inc.	50 96%	2 4%	0 0%	52
Piper's Landing	51 47%	55 50%	3 3%	109
Sailfish Point	14 8%	140 78%	26 14%	180
South Martin Regional Utility	2324 50%	1892 40%	477 10%	4693
Stuart	1,625 92%	115 6%	32 2%	1,772
Not in a Service Area	14,036 56%	8,462 34%	2,454 10%	24,952
Martin County Totals	25,435	14,250	3,717	43,402

Source: Year 2000 Martin County Property Appraisers data and District Regulation files.

Table E-2. Analysis of St. Lucie County Housing Stock in Relation to Indoor Plumbing Code Changes.

Utility Service Area	Housing Stock			
	Pre 1984	1985-1994	Post 1994	Total
Ft. Pierce Utilities Authority	13,586 75%	3,675 20%	932 5%	18,193
Harbour Ridge	2 0%	437 94%	28 6%	467
Panther Woods	1 1%	95 84%	17 15%	113
Port St. Lucie	13,456 37%	17,842 49%	5,431 15%	36,729
Spanish Lakes Fairways	536 48%	499 45%	79 7%	1,114
St. Lucie County North/Holiday Pines	0 0%	0 0%	252 100%	252
St. Lucie West	0 0%	271 38%	443 62%	714
Not in a Service Area	3,263 62%	1,655 31%	379 7%	5,297
St. Lucie County Totals	30,844	24,474	7,561	62,879

Source: Year 2000 St. Lucie County Property Appraisers data and District Regulation files.

Rain Sensor Rule

To determine housing with greater potential for outdoor retrofits, the unit age was compared to years when rain sensor law changed (pre-1992 and post-1992). **Tables E-3** and **E-4** show the counts and percentages of units constructed in the two time periods in each county by utility service area.

Table E-3. Analysis of Martin County Housing Stock in Relation to Rain Sensor Rule.

Utility Service Area	Housing Stock		
	Pre 1992	Post 1992	Total
Indiantown Water Co.	805 92%	72 8%	877
Martin County – Martin Downs	1,546 81%	363 19%	1,909
Martin County – North	3,739 94%	247 6%	3,986
Martin County – Port Salerno	4,038 91%	393 9%	4,431
Martin County – Tropical Farms	403 91%	38 9%	441
Miles Grant/Utility Inc.	52 100%	0 0%	52
Piper's Landing	106 97%	3 3%	109
Sailfish Point	139 77%	41 23%	180
South Martin Regional Utility	3,970 85%	723 15%	4,693
Stuart	1,728 98%	44 2%	1,772
Not in a Service Area	21,394 86%	3,558 14%	24,952
Martin County Totals	37,920	5,482	43,402

Source: Year 2000 Martin County Property Appraisers data and District Regulation files.

Table E-4. Analysis of St. Lucie County Housing Stock in Relation to Rain Sensor Rule.

Utility Service Area	Housing Stock		
	Pre 1992	Post 1992	Total
Ft. Pierce Utilities Authority	16,870 93%	1,323 7%	18,193
Harbour Ridge	393 84%	74 16%	467
Panther Woods	92 81%	21 19%	113
Port St. Lucie	29,211 80%	7,518 20%	36,729
Spanish Lakes Fairways	991 89%	123 11%	1,114
St. Lucie County North/Holiday Pines	0 0%	252 100%	252
St. Lucie West	232 32%	482 68%	714
Not in a Service Area	4,751 90%	546 10%	5,297
St. Lucie County Totals	52,540	10,339	62,879

Source: Year 2000 St. Lucie County Property Appraisers data and District Regulation files.

FLORIDAN AQUIFER

Upper East Coast Comprehensive Floridan Aquifer Monitoring Well Network

The Upper East Coast (UEC) Planning Area covers approximately 1,200 square miles and includes Martin and St. Lucie counties, as well as a small portion of eastern Okeechobee County. Agriculture is the major land use in the area with citrus being the dominant crop. Citrus crops are primarily irrigated with surface water from canals. The Floridan Aquifer is used by growers as a supplemental source when surface water availability is limited, and as a primary irrigation source when surface water is not available (SFWMD, 1998). In most cases, water from the Floridan Aquifer has a high salinity (relative to surface water) and has to be blended with surface water or water from the Surficial Aquifer before it is used for irrigation.

The Floridan Aquifer in the UEC Planning Areas is a relatively unused water source for public water supply, as it located approximately 900 feet below land surface. Citrus farmers mainly use water from the Floridan Aquifer as a supplemental source of irrigation in the region. Currently, most of the public water supply for the region comes from the shallower Surficial Aquifer as it has better quality water. However, the use of the Floridan Aquifer by utilities is increasing and most coastal utilities in the region plan to use the Floridan Aquifer to meet their future needs. Utilities either blend the Floridan water with fresh water or treat it using reverse osmosis.

Network Purpose

Preliminary evaluations presented in the UEC Water Supply Plan (SFWMD, 1998) indicated that the Floridan Aquifer could meet current and projected future urban and agricultural water use demands. However, there is little information on long-term ramifications to water quality in the aquifer from sustained withdrawals. The SFWMD recommended establishing a comprehensive Floridan Aquifer monitoring well network, the UECFAS, to evaluate the effects of sustained withdrawals on the aquifer (Recommendation 3.2, SFWMD, 1998).

The purpose of the UECFAS is to provide water level, water quality and water use data across the UEC Planning Area and determine statistical trends and relationships between the three data sets. Understanding these relationships will help the District better allocate and plan for water supply in the region.

Review of Previous Monitoring Well Networks

The UECFAS was designed using wells from two previously established networks in the region: the District's potentiometric network and the U.S. Department of Agriculture–Natural Resource Conservation Service's (USDA–NRCS or NRCS) network established in 1996. The District's potentiometric network was established in the late 1980s and includes wells in Glades, Highlands, Okeechobee, Martin, Palm Beach and St. Lucie counties. Water level measurements are collected twice a year from the wells in this network: during the dry season and the wet season. This water level data is combined with water level data from other water management districts to develop and publish semi-annual potentiometric surface maps of the Floridan Aquifer. The NRCS established their network in 1996 under a cooperative agreement with the District in an effort to determine water use from the Floridan Aquifer wells for citrus crop irrigation. This network was established as part of the *Indian River Lagoon Surface Water Improvement and Management Plan* to document the frequency, quantity and timing of water use from the aquifer. This initial NRCS network consisted of 45 wells at 16 sites and was later expanded to include 57 wells at 21 sites. As previously mentioned, the NRCS network was fully integrated into the comprehensive network under a cooperative agreement in 1999.

The UECFAS selected wells from the two aforementioned sources to establish a comprehensive set of monitoring sites across the UEC Planning Area. Laying the foundation of the UECFAS began in 1999 when potential wells were selected from District and NRCS sites. A cooperative agreement between the two agencies merged the NRCS sites with selected District sites into one monitoring network covering the UEC Planning Area. The agreement directs the District to manage the wells selected from the potentiometric network and the NRCS to manage the wells selected from their network. By the end of 2000, the water use and water quality components of the UECFAS were established. The water level component was not fully implemented until mid-2002, due to several logistical reasons involving the installation of water level recorders on the artesian wells.

Network Design and Composition

This section describes the design and composition of the UECFAS and its primary objectives. Several factors that led to the final design of the network are also discussed, including the data collection methods

The first stage in designing any monitoring well network is to determine the objectives of the monitoring program (Heath, 1976; O'Hearn and Schock, 1984; and Moore, 1983). The main objective of the UECFAS is to collect water level, water quality and water use data from the Floridan Aquifer focusing on areas with relatively high Floridan Aquifer water use. The long-term trends in each data set will be evaluated, as well as any relationships between the three.

The UECFAS was designed to cover Martin and St. Lucie counties. Over 90 percent of the wells are owned by private landowners and are monitored based on the willingness of the owner to participate in this study. The District obtained access agreements for 12 sites in its potentiometric network. The NRCS received permission to monitor all 45 wells in its network. In 2001, the NRCS added 15 wells (at 5 sites) to provide additional sampling points and improve the UECFAS's coverage. The distribution of the monitoring wells across the UEC Planning Area is shown in **Figure E-1**. The sites in **Figure E-1** are identified with a number: the site name corresponding to each number is listed in **Table E-5**.

Twelve of the wells the District monitors tap the upper Floridan Aquifer and two penetrate the lower Floridan Aquifer (SLF-14 and SLF-74). Three monitoring wells, SLF-74, SLF-75 and SLF-76 (location 12 in **Figure E-1**) are located on the District right-of-way adjacent to the C-24 Canal in central St. Lucie County. These three wells were installed by the District as part of a separate hydrogeologic investigation (Lukasiewicz and Smith, 1996) in the UEC Planning Area and are the only dedicated monitoring wells (not used for agriculture) in the network. The locations of the District monitoring wells are identified in **Figure E-1**.

By 2002, NRCS monitored 57 wells at 21 different sites in the UECFAS. These wells are privately owned and the NRCS maintains the wells and collects data from them. All wells monitored by the NRCS are used for citrus grove irrigation and all are completed into the upper Floridan Aquifer. The locations of the NRCS monitored wells are also shown in **Figure E-1. Table E-5** lists the wells currently in the UECFAS.

The UECFAS will allow the District to better assess current and plan for future groundwater conditions in the UEC Planning Area's Floridan Aquifer.

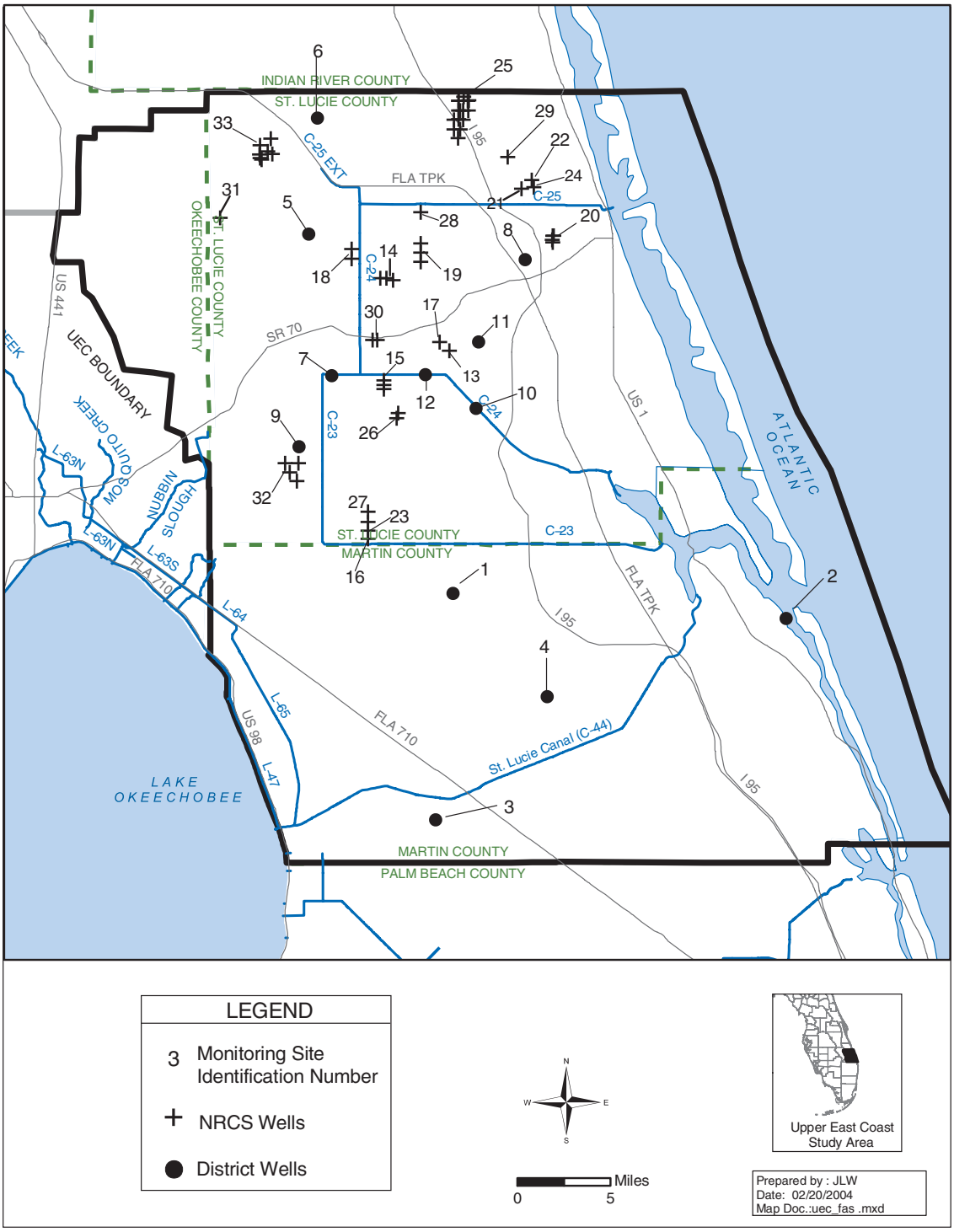

Figure E-1. Distribution of Monitoring Wells in the UECFAS.

Table E-5. Wells in the UEC Comprehensive Floridan Aquifer Monitoring Well Network.

Map Site ID	Site Name	County	Number of Wells at Site	Monitored By	Data Collected
1	MF-9	Martin	1	SFWMD	WQ[b]
2	MF-3	Martin	1	SFWMD	WQ[b]
3	MF-35B	Martin	1	SFWMD	WL[a], WQ[b]
4	MF-52	Martin	1	SFWMD	WL[a], WQ[b]
5	SLF-9	St. Lucie	1	SFWMD	WQ[b]
6	SLF-11	St. Lucie	1	SFWMD	WQ[b]
7	SLF-14	St. Lucie	1	SFWMD	WL[a], WQ[b]
8	SLF-21	St. Lucie	1	SFWMD	WL[a], WQ[b]
9	SLF-60	St. Lucie	1	SFWMD	WQ[b]
10	SLF-62B	St. Lucie	1	SFWMD	WL[a], WQ[b]
11	SLF-69	St. Lucie	1	SFWMD	WL[a], WQ[b]
12	C-24 Site	St. Lucie	3	SFWMD	WL[a], WQ[b]
13	Grove #1	St. Lucie	1	NRCS	WQ[b], WU[c]
14	Grove #2	St. Lucie	3	NRCS	WL[a], WQ[b], WU[c]
15	Grove #3	St. Lucie	3	NRCS	WQ[b], WU[c]
16	Grove #4	St. Lucie	1	NRCS	WQ[b], WU[c]
17	Grove #5	St. Lucie	1	NRCS	WQ[b], WU[c]
18	Grove #6	St. Lucie	2	NRCS	WQ[b], WU[c]
19	Grove #7	St. Lucie	3	NRCS	WQ[b], WU[c]
20	Grove #8	St. Lucie	4	NRCS	WQ[b], WU[c]
21	Grove #11	St. Lucie	1	NRCS	WL[a], WQ[b], WU[c]
22	Grove #12	St. Lucie	1	NRCS	WL[a], WQ[b], WU[c]
23	Grove #13	St. Lucie	1	NRCS	WQ[b], WU[c]
24	Grove #14	St. Lucie	1	NRCS	WQ[b], WU[c]
25	Grove #29	St. Lucie	15	NRCS	WL[a], WQ[b], WU[c]
26	Grove #35	St. Lucie	2	NRCS	WL[a], WQ[b], WU[c]
27	Grove #36	St. Lucie	2	NRCS	WQ[b], WU[c]
28	Grove #121	St. Lucie	1	NRCS	WL[a], WQ[b], WU[c]
29	Grove #201	St. Lucie	1	NRCS	WL[a], WQ[b], WU[c]
30	Grove #202	St. Lucie	2	NRCS	WQ[b], WU[c]
31	Grove #203	St. Lucie	1	NRCS	WL[a], WQ[b], WU[c]
32	Grove #204	St. Lucie	4	NRCS	WL[a], WQ[b], WU[c]
33	Grove #205	St. Lucie	7	NRCS	WL[a], WQ[b], WU[c]

a. WL – Water level data (readings collected every 15 minutes).

b. WQ – Water quality data (monthly specific conductance readings, quarterly chloride and total dissolved solids data).

c. WU – Water use data (collected monthly).

Data Collection Objectives and Methods

This section discusses the different types of data collected from the UECFAS.

Water Level Data Collection

There are currently 18 sites that collect continuous (15 minute interval) water level data in the UECFAS. The District maintains six sites and the NRCS maintains the other 12 sites. Electronically collected water level data will allow for a detailed evaluation of water levels in the Floridan Aquifer because of the high frequency at which they are collected. Hydrographs developed for each well should show water level trends over time. Seasonal variations, as well as long-term water level trends will be recorded. Data from the District maintained sites are stored in DBHYDRO, the District's main database. Plans are underway to upload the data from the NRCS maintained sites into DBHYDRO.

The six sites that the District currently maintains have been equipped with a Campbell Scientific CR10 data logger and a Rittmeyer (Model MPxSGRN) pressure transducer. Each pressure transducer is rated at 30 pounds per square inch (psi) and mounted on top of the wellhead. The water level recorders are connected to a telemetry system that sends data back to the District daily. A water level reading is collected every 15 minutes and stored in the data logger's storage module. Data for these six sites is available from September 2001 to present.

The NRCS has installed electronic water level recorders that consist of In-Situ, Inc., MiniTroll (professional model) data loggers in each well. Each MiniTroll is rated at 30 psi and is set in each well approximately 30 feet from the top of the wellhead. Each MiniTroll collects a water level reading every 15 minutes and stores it in the instruments internal memory. Unlike the District sites, which have telemetry, NRCS personnel visit each well monthly and manually download data from the loggers onto a laptop computer. The water level data is then sent to the District electronically each month.

Water Quality Data Collection

Water quality samples are collected on two separate schedules: monthly specific conductance samples from all NRCS monitored wells, quarterly chloride, total dissolved solids (TDS) samples and specific conductance samples from selected wells that both the District and NRCS monitor.

The NRCS collects specific conductance data monthly from each of the 57 wells they monitor. After purging each well, a specific conductance reading is taken in the field with a handheld water quality probe. The probe is calibrated daily and checked against a known standard. The NRCS sends the specific conductance data and calibration logs to the District in a quarterly report.

Water quality data collected on a quarterly schedule are available from January 2001 to present for selected wells in the UECFAS. The District retained a contractor (GFA International) to collect water quality samples from the wells the District is responsible for. The NRCS collects water quality samples from the wells they monitor. These samples will allow the District to gauge water quality changes in the aquifer on a seasonal, as well as a long-term basis. Before a water sample is collected, each well is allowed to flow (purged) at least three well volumes. This procedure ensures that the water samples are representative of the aquifer and not of water stored in the well bore. Both the District contractor and the NRCS follow the District's quality assurance/quality control (QA/QC) protocol when collecting these water quality samples. Specific conductance samples are collected after purging is complete and are measured in the field with a calibrated handheld water quality probe. All Chloride and TDS samples are collected in the appropriate sample containers, after purging is complete. These samples are sent to a state certified analytical laboratory (US Biosystems) for analysis. Water quality data from the UECFAS are stored in DBHYDRO, the District's primary database. Data collected by the District is stored under the project code "UECF." Data collected by the NRCS is stored under the project code "NRCS."

Water Use Data Collection

As part of the cooperative agreement with the District, the NRCS installed flow meters on the 57 wells they monitor. Water use data is only available for the NRCS portion of the UECFAS. Collecting water use data involves reading each flow meter once a month and recording the amount of water used. The NRCS sends the water use data to the District in a quarterly report along with the monthly water quality data they collect. The water use data will be plotted to reveal any trends. The objective is to discover seasonal variations and long-term trends. In addition, annual water use totals for each grove will show which groves frequently use water from the Floridan Aquifer and if the use is continuous from year to year or only during times of a water shortage.

Rainfall Data Collection

In conjunction with the water level, water quality and water use data, the NRCS also collects rainfall data at each site they monitor. There are 21 rain gauges distributed across St. Lucie County where the NRCS collects rainfall data monthly. Rainfall data is useful in showing when the wet and dry seasons start and the annual rainfall in the region and may relate to detected trends in water use.

Network Maintenance

Currently, most work with the UECFAS involves collecting data from the wells and performing a variety of maintenance tasks. The maintenance tasks are as follows.

Data Logger Maintenance

Data logger maintenance, whether it is a CR10 or a MiniTroll, involves changing desiccant packs, ensuring the internal batteries are charged and checking to ensure that the equipment and protective housing are functional. The maintenance also involves calibrating each data logger and verifying that it is collecting accurate measurements. This maintenance is performed monthly as the desiccant packs require frequent changing due to the high humidity in south Florida.

Wellhead Maintenance

From time to time several wellheads develop leaks and/or rupture, requiring repair. Most of the wells in the UECFAS are over 20 years old, and these problems develop as the highly mineralized water in the Floridan Aquifer corrodes the steel wellheads. Both the District and the NRCS hire certified well drilling companies to repair damaged wellheads.

Flow Meter Maintenance

The NRCS performs routine maintenance on each flow meter to ensure that they remain calibrated and operational. They inspect each meter monthly, while on site collecting flow meter readings. The maintenance also involves calibrating each flow meter as needed and verifying that it is collecting accurate measurements. An independent contractor certified by the flow meter manufacturer performs flow meter calibration. These inspections enable the NRCS to identify faulty meters in a timely manner, have them repaired and minimize any gaps in the data record.

Data Summary

This section presents a summary of the data collected since the network was developed in 1999. Initial data analysis included tabulating and graphing the data to look for trends. A secondary analysis included a correlation between the data sets to see if there were any relationships between them.

Water Level Data

Continuous water level data are available for 18 wells from late 2001 to present. Hydrographs for each well show water levels generally decreased during the dry season, reaching “lows” in May of each year. During the wet season, the water levels generally rise to “highs” in September/October of each year. The hydrograph for some wells show several sharp dips that look like straight lines. Since the wells in the UECFAS are artesian, these dips represent times when the well was used for irrigation and indicate the pressure drop that occurred when the landowner opened the wellhead valve. A more thorough discussion of the water level data will take place in a separate technical report when more data is available to assess seasonal and long-term trends. Additional water

level data will allow for trend comparisons with the water quality and water use data. Hydrographs from two selected wells are presented below. One hydrograph represents a well that is used frequently for citrus irrigation (**Figure E-2**) and the other a well used strictly for monitoring (**Figure E-3**).

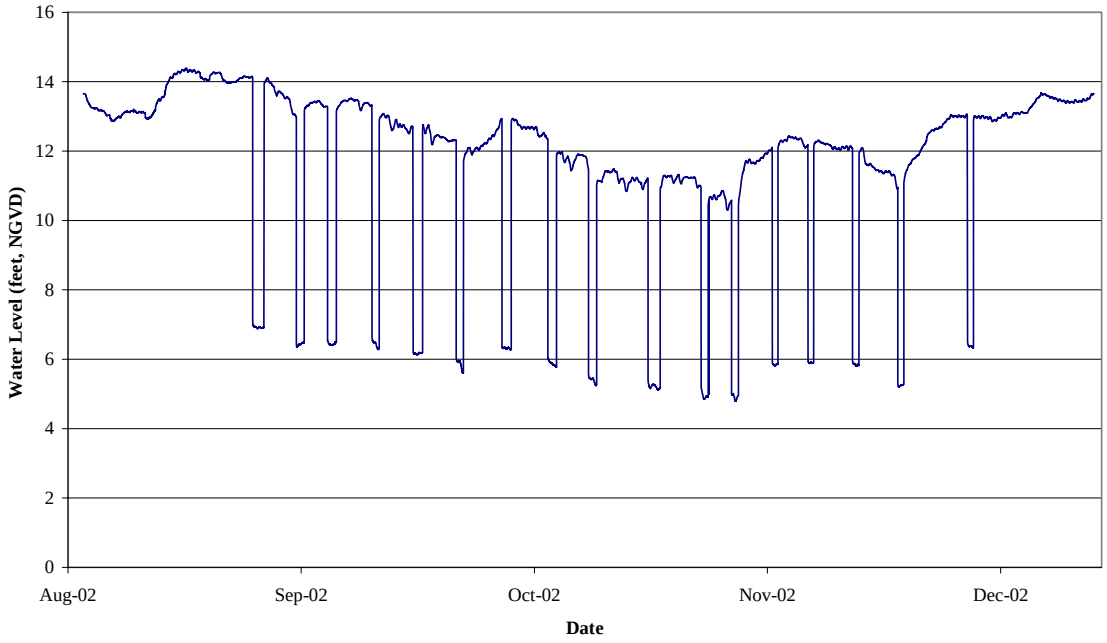

Figure E-2. Hydrograph of Well SLF-21 (Site 8 on **Figure E-1**).

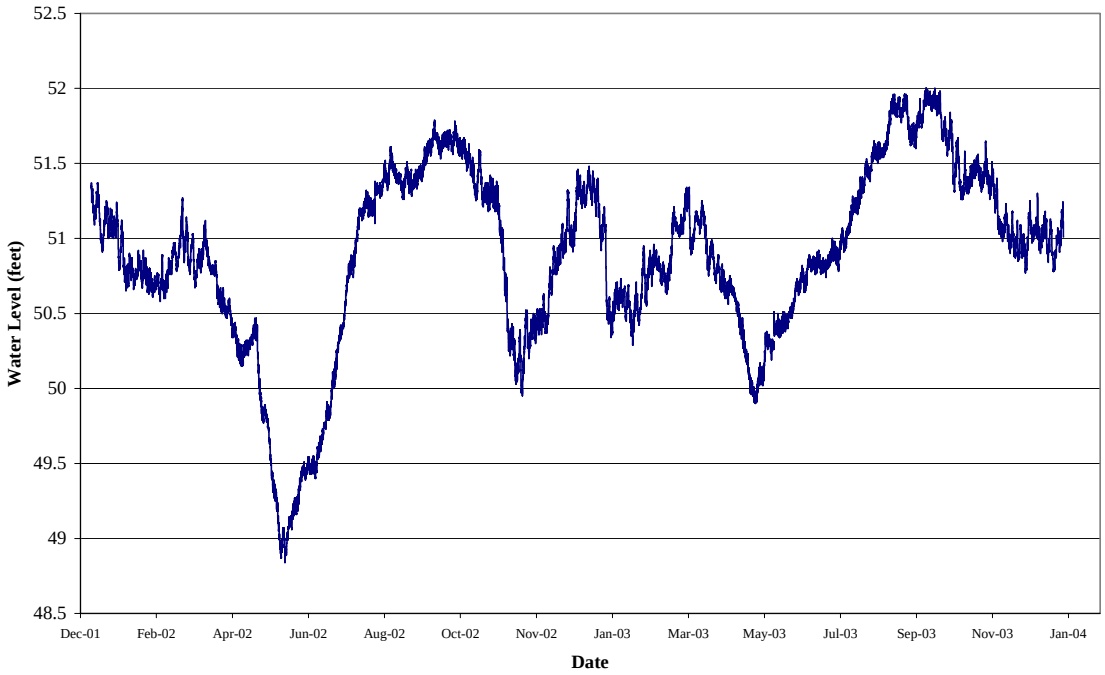

Figure E-3. Hydrograph of Well MF-52 (Site 4 on **Figure E-1**).

Water Quality Data

Water quality data has been collected in various forms from the UECFAS as follows:

- NRCS monthly specific conductance data from 1999
- NRCS quarterly chloride and TDS data from January 2001
- District quarterly chloride and TDS data from January 2001

Specific Conductance Data

Specific conductance data is available from 1999 for 42 wells monitored by the NRCS. Data is available for the remaining 15 NRCS wells, but the period of record is not as extensive (start date of April 2002). Plots of the specific conductance data generally show a sinusoidal trend. The graphs were constructed with the date of data collection on the x-axis and specific conductance on the y-axis. The plots generally show that specific conductance peaks in the mid-to-late dry season (March to April) and was at a low in the early dry season (December) (**Figure E-4**).

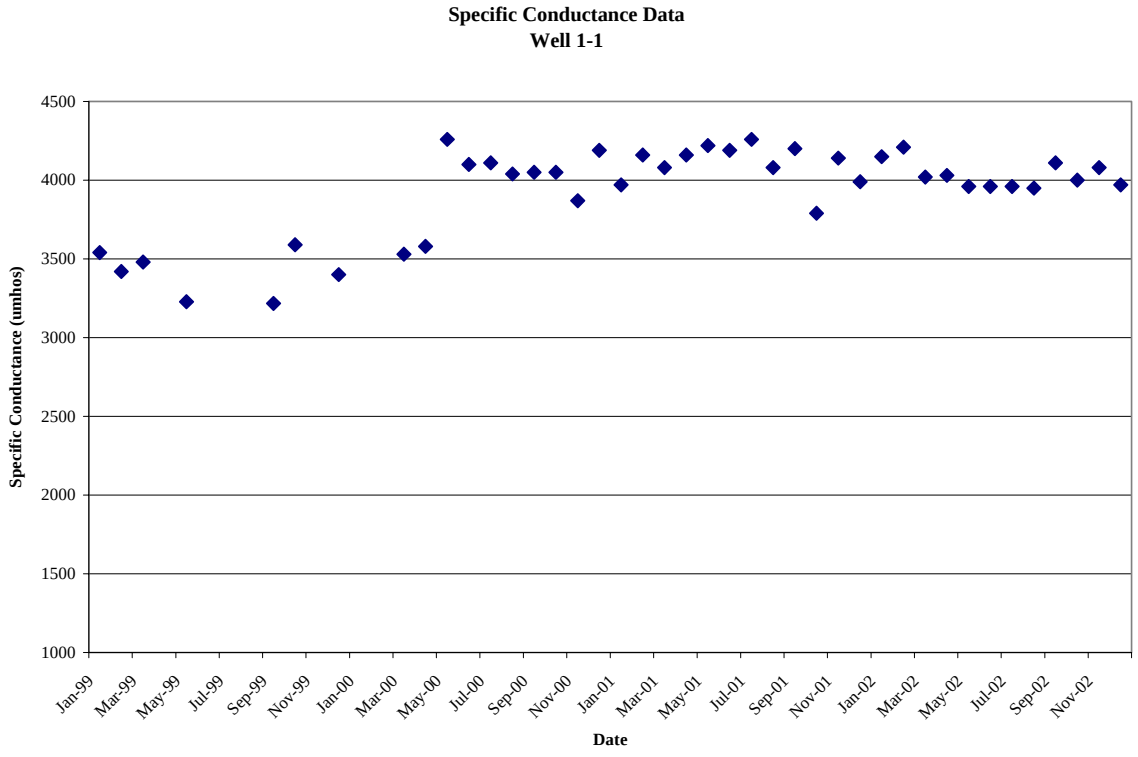

Figure E-4. Specific Conductance Data for Well 1-1.

Specific conductance values for all the wells ranged from 660 to 7,900 microsiemens per centimeter (µs cm^{-1}) between January 1999 and December 2002. The mean and median of the sample population are 2,934 µs cm^{-1} and 2,780 µs cm^{-1}, respectively. The data was averaged for each year in order to determine trends in each

well. An increasing trend in specific conductance is considered to be a 10 percent increase in the annual average over the period of record for each well.

Reviewing the annual mean revealed some trends in specific conductance in each well. Of the 57 wells with data, 38 showed an increasing trend in specific conductance, while 17 remained constant between 1999 and 2002. Two wells only had one year of data available so a trend could not be established. The mean and median specific conductance values for the region have increased between 1999 and 2002. The mean regional specific conductance value increased from 2,563 to 3,044 $\mu s\ cm^{-1}$. The median regional specific conductance value increased from 2,519 to 2,888 $\mu s\ cm^{-1}$. This increase in specific conductance may be an effect of the water shortage that the District experienced in 2000 and 2001. During these years, lower rainfall in Florida resulted in less recharge to the aquifer probably resulting in higher specific conductance values in the wells.

Chloride Data

Quarterly chloride data from January 2001 to December 2002 were reviewed for this report. Chloride concentrations ranged from 270 and 1,800 milligrams per liter (mg/l) for the total sample population. The mean and median of the sample population are 948 mg/l and 890 mg/l, respectively. Currently, there is insufficient data to perform a temporal trend analysis in each well for chlorides, even to compare it with other data sets.

Total Dissolved Solids Data

Quarterly TDS data is available from January 2001 to December 2002 for this report. TDS concentrations ranged from 410 mg/l to 5,900 mg/l over the UEC Planning Area for the total sample population. The mean and median of the sample population are 2,122 mg/l and 2000 mg/l, respectively. Currently, there is insufficient data to perform a detailed trend analysis in each well for the TDS data. In general, the available data shows that TDS fluctuations are greater in magnitude and occurrence than those for the specific conductance and chloride data.

Water Use Data

Each of the 57 wells that the NRCS monitors is equipped with a flow meter. Totalized flow meter readings (in gallons) are colleted monthly to determine the amount of water used for irrigation. Plots of the water use data show that there was no definitive trend in monthly water use at any of the sites. The plots were constructed with the date of data collection on the x-axis and water use on the y-axis. The only commonality seen in the plots is that most wells were used for irrigation during the early portion of 2000 and 2001 when the District was experiencing a water shortage.

Ranking the top water users shows the sites that use the most water every year. The ranking also reveals water use patterns, e.g. does the same site using the same amount of water every year. The top ten water users over the last four years (1999 to 2002) are listed in **Table E-6**.

Table E-6. Top Ten Water Users from 1999 to 2002.

Rank	Total Water Use 1999 to 2002 (Gallons)	
	Water Use	Well
1	9,908,381	29-14
2	8,490,056	6-2
3	6,234,953	6-1
4	3,745,828	29-11
5	3,102,109	29-5
6	2,943,456	5-1
7	2,759,202	29-9
8	2,654,314	4-1
9	2,479,339	29-2
10	2,063,655	1-1

By the end of 2002, Well 29-14 recorded the highest water use over the last four years. This well has consistently been the highest user since the UECFAS was established. Well 29-14 is located in northeast St. Lucie County away from major surface water sources and relies on water from the Floridan Aquifer as a supplemental irrigation source. The second ranked water user over the same period was Well 6-2. However, approximately 90 percent of this well's water use occurred over a two-year period (2000 and 2001). The two years of high water use for this well coincide with two years when the District was experiencing a water shortage. Well 6-2 is located along the north-south stretch of the C-24 Canal in western St. Lucie County. Ordinarily, this user relies on surface water for irrigation. However, the water use restrictions in place during the 2000 and 2001 water shortages limited the use of surface water for irrigation. As a backup, this user drew water from its wells to supplement irrigation. The remaining top 10 water users had similar patterns of water use: constant high water use over the period of record or two years of high use during the water shortage.

Rainfall Data

Graphs of rainfall data between 1999 and 2002 displayed the distinct wet and dry season pattern attributed to south Florida. Typically, the majority of annual rainfall occurred between May and September. September was frequently the month with the highest precipitation over the four-year period of record.

Correlation Analysis

A correlation analysis was performed to try and determine a statistical relationship between the following data sets:

- Water quality and water use
- Water levels and water use
- Water levels and water quality

The results of the correlation analyses are provided in **Table E-7**.

Table E-7. Summary of Correlation Analyses.

Data Sets Compared	Correlation Coefficient Range
Water Quality and Water Use	-0.32 to 0.51
Water Levels and Water Use	-0.54 to 0.43
Water Levels and Water Quality	-0.07 to 0.45

The analyses yielded correlation coefficients between -0.54 and 0.51. A correlation coefficient of 1.00 represents a perfect relationship. A correlation coefficient of 0.00 represents the absence of a relationship. Similarly, a correlation coefficient of -1.00 represents a perfect inverse relationship. These correlation coefficients show that there is little to no relationship between the aforementioned data sets at this time. Further study is required to determine the relationship between the three data sets.

Conclusions

With only about a two-year period of record, hydrographs for the network wells show a pattern of "low" water levels every May and "high" levels every September/October. There is insufficient data at this time to determine the long-term water level trends in the aquifer.

Specific conductance data in most wells shows a sinusoidal trend with higher values in the mid-to-late dry season (March to April) and lows in the early dry season (December). It appears that recharge from wet season precipitation may reduce the specific conductance in the aquifer. The effect of this recharge is not seen until the early dry season when specific conductance values decrease. Recharge does not occur locally as the Floridan Aquifer is confined and lies approximately 1,000 feet below land surface in the UEC Planning Area. Recharge occurs to the northwest of UEC Planning Area along the Lake Wales Ridge, where the aquifer is unconfined to thinly confined. The calculated mean specific conductance for each well showed that the average specific conductance in 38 wells had an increasing trend (mean specific conductance rose from 2,563 to 3,044 $\mu s\ cm^{-1}$) between 1999 and 2002. Similarly, the average specific conductance in 18 wells remained the same in 34 wells over the same period. These increases in specific conductance may be an effect of the water shortage that the District experienced in 2000 and 2001. During these years, lower rainfall in Florida resulted in less recharge to the aquifer resulting, generally, in higher specific conductance values in the wells.

As with the water level data, it is hard to determine trends in the chlorides and TDS due to the current lack of available data.

There is no specific trend in monthly water use. Landowners use their wells with no specific frequency. The top ten water users between 1999 and 2002 fell into two categories: (1) those that used a constant amount of water and (2) those that had very high

water use in one to two years. The data showed that water use was greatest during 2000 and 2001, the years in which the District was experiencing a water shortage.

At this time, there is no correlation among water level, water quality and water use data in the UEC Planning Area. With the addition of more data every month, another trend and correlation analysis should be completed at the end of each year. This new analysis may reveal relationships between water levels, water quality and water use in the region.

SURFACE WATER

CERP Ten Mile Creek Project

Please see the following map (**Figure E-5**) representing the CERP Ten Mile Creek Project.

Figure E-5. Ten Mile Creek Critical Restoration Project Map.

CERP Indian River Lagoon – South Project

Please see the following map (**Figure E-6**) representing the CERP Indian River Lagoon – South Project.

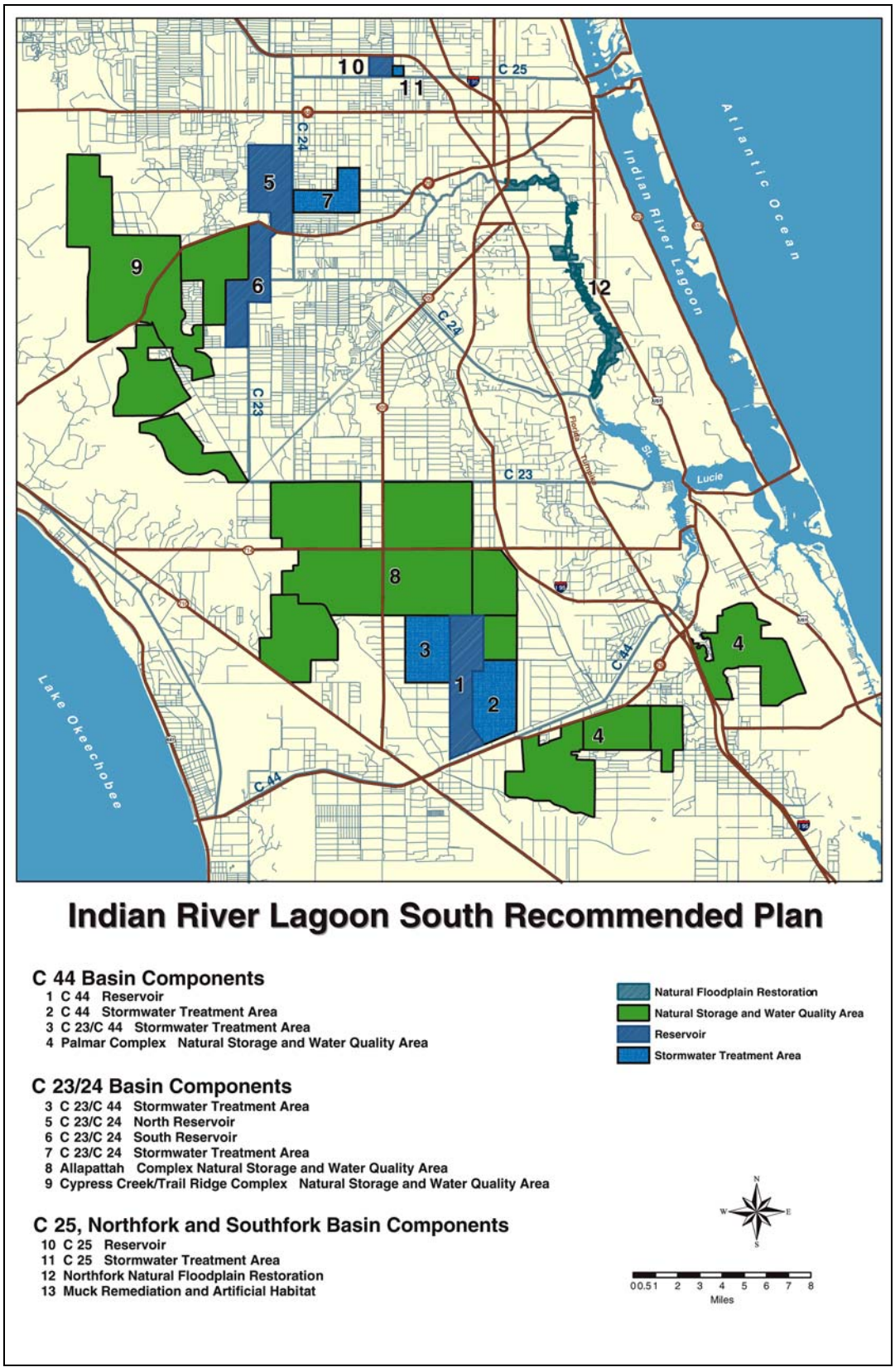

Figure E-6. Indian River Lagoon – South Project Map.

REFERENCES CITED

Florida Department of Environmental Protection. 2002. *Florida Water Conservation Initiative.* Tallahassee, FL. 163 pp.

Heath R.C., 1976. *Design of Ground-Water Level Observation-Well Programs.* Ground Water, Vol. 14, No. 2, 71-77 pp.

Lukasiewicz, J. and Smith, K.A., 1996. *Hydrogeologic Data and Information Collected from the Surficial and Floridan Aquifer Systems, Upper East Coast Planning Area.* South Florida Water Management District, Technical Publication 96-02, West Palm Beach, FL.

Moore, R.E., 1983. *Defining the Basic Objectives of a Ground-Water Program, State, County, Regional and Municipal Jurisdiction of Ground-Water Protection*. National Water Well Association, Worthington, OH, 291-300 pp.

O'Hearn M., and Schock S. C., 1984. *Design of a Statewide Ground-Water Monitoring Network for Illinois.* Illinois Department of Energy and Natural Resources, Champaign, IL.

South Florida Water Management District, 1998. *Upper East Coast Water Supply Plan: Planning Document.* South Florida Water Management District, West Palm Beach, FL.